EASTERN RESEARCH GROUP, INC.

MEMORANDUM

TO: Bill Maxwell, U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning Standards (OAQPS) (MD-13)

FROM: Heather Wright, Eastern Research Group (ERG), Morrisville

DATE: December 1, 1998

SUBJECT: Final Summary of the July 30, 1998 Meeting of the Industrial Combustion Coordinated Rulemaking (ICCR) Process Heater Work Group

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1.0 INTRODUCTION

- The purpose of the meeting was to allow attendees to discuss various activities of the ICCR Process Heater Work Group (PHWG). The flash minutes for the meeting are included as attachment 1 and the meeting agenda is included as attachment 2.
- The meeting was held on July 30, 1998 in Long Beach, California.
- A complete list of meeting attendees with their affiliations is included as attachment 3.

2.0 SUMMARY OF DISCUSSION AND DECISIONS

Work Group discussions are summarized in the following sections:

2.1 Review of Coordinating Committee Meeting
2.2 ICCR FACA Charter
2.3 Update on the Database Analysis
2.4 Presentation on Coke Oven Gas
2.5 MACT Documentation

2.1 Review of Coordinating Committee Meeting

John Ogle led a discussion of the major issues addressed by the Coordinating Committee (CC) on July 28 and 29 prior to the PHWG meeting. Mr. Ogle provided the following updates:

- Bruce Jordan discussed EPA's decision not to renew the Federal Advisory Committee Act (FACA) charter for the ICCR. He commented that the Work Groups have provided EPA with beneficial information over the past two years and encouraged stakeholders to continue to participate in the rulemaking process. The EPA will continue to maintain a website for distributing information and documents for review; the list server will continue to function in the same manner.

- The last CC meeting will be held in September to allow the Work Groups to summarize their work and finalize it to the extent possible. Each Work Group must identify closure items, works in progress, and informational items. All items presented at the CC meeting will be forwarded to EPA for consideration in the rulemaking process, but works in progress and informational items will be given less weight than closure items. In addition, any individual will be free to submit additional comments for EPA's consideration after the September meeting.

- By August 31, Work Groups must submit a status report (bulleted list) to EPA on the information to be presented for closure at the September CC meeting, as well as works in progress, and other informational items.

- Work Groups must submit the materials/information that will be discussed at the upcoming CC meeting to EPA by September 4.

- Mr. Ogle stated that one individual had commented that progress by the source Work Groups was slowed because EPA failed to draft a useable solid waste definition. EPA indicated that a definition on solid waste may not be finalized until just before promulgation. An update on the solid waste definition will be presented at the September CC meeting.

- The Incinerator Work Group presented their draft regulatory alternatives paper (RAP). The CC reached consensus to forward the RAP to EPA as a draft. The Incinerator Work Group will present a revised version of the RAP at the September CC meeting.

- The Boiler Phase I test plan is being forwarded to EPA as a CC recommendation. The Boiler Work Group believes that the data will help them to evaluate control devices and further refine their subcategories. The Boiler Work Group also presented information on Phase II of their test plan.

- Previously, the CC recommended that a MACT floor for combustion turbines could not be identified based on permit requirements and test results. The EPA reviewed this recommendation and found it to be a logical conclusion based on available data.

- The Children's Health Executive Order and draft interim guidance on its implementation, including how it may affect MACT standards, was discussed.

- The CC discussed how testing should be prioritized. The CC reached consensus on the statement: "To the extent resources for emission testing may be limited, it is the general sense of the ICCR CC that resources should be focused on incinerators as defined in CAA Section 129, boilers, and engines." Mr. Ogle stated that this could have an impact for process heaters, as some units may burn solid waste.

- Testing is currently underway for Reciprocating Internal Combustion Engines (RICE). The EPA is preparing to initiate testing for combustion turbines and boilers, but has not yet determined the extent of that testing. The Incinerator Work Group submitted a test plan which will also be considered.

- The Environmental Caucus presented a proposal on permitting and environmental justice. Mr. Ogle stated that many CC members indicated that the presentation was premature. The caucus members will consider the comments made at the CC meeting and present a revised proposal in September.

- The CC reached consensus to forward the RICE subcategories and MACT floors to EPA as a CC recommendation.

- Dave Smith mentioned that the RICE Work Group presented slides to clarify what MACT floor is, how it differs from final MACT, and what a MACT floor of no control means. Mr. Smith suggested that the PHWG make similar slides to accompany their presentation in September.

- Jane Williams commented that the RICE Work Group did not state whether they investigated fuel switching (for example, use of low sulfur fuels) as a control technology.

2.2 ICCR FACA Charter

- Bill Maxwell explained that the ICCR FACA charter was extended through September to allow the Work Groups to finalize and/or summarize their current works in progress. Mr. Maxwell stated that all items which the PHWG would like EPA to consider must be presented at the September CC meeting.

- After September 20, 1998, the PHWG will disband, but all members are encouraged to continue participating in the rulemaking process. Input and comments from individuals will continue to be welcomed by EPA. In addition, EPA will be able to meet with individuals or a collection of parties to discuss the rulemaking process. EPA will continue to post draft materials and database information pertaining to process heaters on the TTN, but likely under a new website name (possibly the Process Heater Source Category site). The EPA may also hold public meetings in the future if deemed necessary.

- Mr. Maxwell encouraged the PHWG to finalize as much work as possible for the September CC meeting. It was agreed that the PHWG will not present anything for

closure, but the MACT documentation paper and a status report for other-fired units will be presented as works in progress. The process heater database work will be presented as an informational item.

- The PHWG has made little progress on making RAP determinations and completing the Appendix B forms for 129 fuels, developing above the floor alternatives, or collecting information for the economic analysis.

2.3 Update on the Database Analysis

Jason Huckaby presented a database analysis flow diagram and information on add-on controls for gas and fuel oil-like liquid-fired units (see handouts presented as attachment 4).

- Mr. Huckaby explained that the flow diagram was drafted to account for every process heater unit in the inventory and survey databases. After it was determined which units to remove from the process heater database, the remaining units were grouped into 10 categories, based on fuel type.

- The flow diagram shows that 792 units were removed from the database because they were misclassified and/or found to be errors. Many of those units were actually boilers, incinerators, and turbines. A question arose as to whether the information for the misclassified units was distributed back to the appropriated source Work Groups. Bill Maxwell stated that he would distribute the misclassified information.

- Mr. Huckaby noted that the two units in the coal category will likely be removed, as they are probably not coal-fired units based on current knowledge.

- The fuel oil category includes #2 distillate, #4 fuel oil, and diesel fuel. The residual oil category includes #5 fuel oil and #6 residual oil.

- The term unspecified means that there was no information about the material burned in the unit.

- A request was made to breakout the fuel categories shown in the database analysis flow diagram into controlled and uncontrolled. It was decided that EPA will expand the flow diagram to show the numbers of controlled and uncontrolled units for each of the 10 fuel subcategories.

- Mr. Huckaby made a correction to the residual oil table of add-on controls. The total percentage of combined no add-on control is 89.5% (as opposed to 40.34% shown in the table).

2.4 Presentation on Coke Oven Gas

Dave Ailor and Allen Dittenhoefer presented information on coke oven gas on behalf of the American Iron and Steel Institute (AISI)/American Coke and Coal Chemicals Institute (ACCCI) Coke Oven Environmental Task Force (COETF).

- Dave Ailor presented an overview of the COETF and a status report on their review of the ICCR process heater database (see handouts presented as attachment 5). Mr. Ailor explained that the COETF represents all coal-based coke plants in the U.S. (not those that are petroleum-based). In addition, Mr. Ailor stated that of the 54 process heaters identified in the database as operated by coke plants, 24 units are coke oven batteries firing coke oven gas and are subject to another MACT standard (the coke oven battery NESHAP currently under development). The 30 remaining sources will be assessed by mid-August.

- A question was raised as to whether the number of process heaters in the database firing coke oven gas seems representative of coke plants in the U.S. Mr. Ailor said that the number is dependent on which plants received surveys. He added that not many coke processing plants have process heaters that fire coke oven gas, but that more steel plants do.

- A question was raised concerning whether the units firing coke oven gas have add-on controls. Mr. Ailor said that it is likely they do not. He also stated that efficient combustion, based on good maintenance and operation practices, has a much greater impact on hazardous air pollutant (HAP) emissions than fuel composition. Mary Lalley stated that there are no add-on controls for units firing coke oven gas in the database.

- Another question was raised as to whether the coke processing plants perform operator training. Mr. Ailor explained that operator training is conducted and that automatic feedback controls are often used to regulate the air feed rates.

- Allen Dittenhoefer presented an overview of the findings outlined in the ICCR white paper on coke oven gas (see handouts presented as attachments 6 and 7). Mr. Dittenhoefer presented information on fuel composition, fuel combustion characteristics/volatile organic emissions, particulate matter emissions, and the PERF (Petroleum Environmental Research Forum) project. The information demonstrates that the combustion of coke oven gas results in very low levels of HAP emissions similar to that of natural gas combustion.

- Mr. Dittenhoefer explained that coke oven gas is a by-product generated in the coking process and is cleaned/scrubbed to refine the gas and remove particulates before it is used. Approximately 40% of coke oven gas is used to fire coke batteries and the remaining 60% is used in the plants as fuel for combustion devices such as boilers and

process heaters. A question was raised as to whether facilities ever burn coke oven gas that has not been cleaned. Mr. Ailor said that such gas is sometimes burned as part of the coking process, but not in indirect-fired process heaters.

- A question was raised as to whether metals that are present in coal before the coking process, such as mercury, are transferred to the coke oven gas. Mr. Dittenhoefer stated that most metals remain in the coke and do not enter the gas. In addition, because the gas is cleaned before it is used, it is assumed that the metals content in the coke oven gas is very low.

2.5 MACT Documentation

- Lee Gilmer explained that the MACT Documentation Subgroup is compiling inventory and emissions data, supplemented with data from AP-42 and the WSPA (Western States Petroleum Association) database, to develop a rationale document for gas and fuel oil-like liquids. The MACT Documentation Subgroup is following the same approach that the Combustion Turbine Work Group used for their documentation. The documentation for gas and fuel oil-like liquids will include:

  - a breakdown of units with no add-on controls and those with add-on controls
  - fuel comparisons
  - information on operating practices, load, and the stoichiometric ratio
  - information on inherent process variability and process changes
  - information concerning sampling variability
  - an examination of PERF and WSPA data
  - information on pollution prevention

- The MACT Documentation Subgroup will determine by mid-August how much information they will be able to present at the September CC meeting. In addition, the Subgroup will distribute a draft document to the Work Group on August 17. A conference call to discuss the draft is tentatively scheduled for August 21 at 11 a.m. Eastern time. A revised document will be distributed to the Work Group on August 31.

- A question arose as to whether the good combustion practices and operator training documents produced by the PHWG were forwarded to the CC. Mary Lalley explained that the Work Group did not come to consensus on them. Lee Gilmer added that the two documents were incorporated into the Pollution Prevention Subgroup recommendations which have been presented to the CC.

- Lee Gilmer stated that the information which the Pollution Prevention Subgroup drafted on good combustion practices and operator training will be addressed in the MACT Documentation paper. Jane Williams stated that it is not appropriate to use the documents to support the floor or to demonstrate that there is no numerical limit, as they were not originally drafted for that purpose. Bill Maxwell reminded the PHWG that during the Combustion Turbine Work Group presentation they were asked how good combustion practices were considered. Thus, it is probably beneficial for the PHWG to include some discussion of good combustion practices and operator training in the rationale document.

- The PHWG determined that it will not be possible to complete documentation for other-fired units before the September CC meeting. It was decided that the Work Group will provide the CC with a brief status report on progress made regarding other-fired units.

- The Other-Fired Process Heater Subgroup will hold a conference call to discuss and/or draft a status report on other-fired units. The call is tentatively scheduled for August 13 at 11 a.m. Eastern time. Documentation for coke oven gas will also be revisited during the call.

- Bill Maxwell added that the emissions database is currently being augmented with approximately 600-800 new reports that were requested from CARB (California Air Resources Board). The majority of incoming test reports are for boilers and incinerators, but there is some additional process heater information being submitted.

3.0 UPCOMING MEETINGS

Two teleconferences are tentatively scheduled prior to the September Coordinating Committee meeting:

- August 13 at 11:00 a.m. Eastern time - the Other-Fired Process Heater Subgroup will discuss and/or draft a status report for the upcoming Coordinating Committee meeting

- August 21 at 11:00 a.m. Eastern time - the entire Work Group will discuss the draft MACT documentation paper

A Work Group meeting is tentatively scheduled for September 15 in Durham, NC.

These minutes represent an accurate description of matters discussed and conclusions reached and include a copy of all reports received, issued, or approved at the July 30, 1998 meeting of the Industrial Combustion Coordinated Rulemaking (ICCR) Process Heater Work Group. Fred Porter, EPA Co-Chair.

Attachment 1

Flash Minutes From The July 30, 1998 Meeting Of The ICCR Process Heater Work Group

ICCR PROCESS HEATER WORK GROUP MEETING

July 30, 1998
Long Beach, California

DECISIONS

The Work Group decided that there will be no closure items for presentation at the September Coordinating Committee meeting. The Work Group will provide their MACT documentation paper as a work in progress. The Work Group also identified the process heater database work as an informational item to be provided to the Coordinating Committee.

The MACT Documentation Subgroup decided to meet on July 31 to continue working on the draft MACT documentation paper.

ACTION ITEMS

The Other-Fired Process Heater Subgroup will have a conference call to discuss and/or draft a brief status report on other-fired units. The call is tentatively scheduled for August 13 at 11 a.m. Eastern time. Documentation for coke oven gas will also be revisited during the call.

The MACT Documentation Subgroup will distribute a draft to the Work Group on August 17. A conference call to discuss the draft is tentatively scheduled for August 21 at 11 a.m. Eastern time. A revised document will be distributed to the Work Group on August 31.

Bill Maxwell will follow-up on emission stack testing to be performed for the coke oven battery MACT and emission test information from the Bethlehem Steel Corporation facility at Burns Harbor, IN.

EPA will post on the Process Heater TTN website the materials and information presented on coke oven gas during the meeting.

Lee Gilmer will work with EPA to investigate add-on controls in the process heater database.

EPA will expand on the “database analysis flow diagram” to show the numbers of controlled and uncontrolled units for each of the 10 fuel subcategories.

EPA will inform the appropriate Work Groups of units in the process heater database that have been determined to be misclassified.

The Work Group will submit to EPA a status report (bulleted list) on the information to be presented for closure at the September Coordinating Committee meeting, works in progress, and other informational items on August 31 for posting to the TTN on September 1.

The Work Group will submit to EPA the materials/information that will be discussed at the upcoming Coordinating Committee meeting by September 4 for posting to the TTN on September 9.

UPCOMING MEETINGS

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Attachment 2

Meeting Agenda

MEETING AGENDA

Process Heaters Source Work Group Meeting
Thursday, July 30, 1998
8:00 a.m. - ? p.m.
Long Beach, CA

When	What	Who	Outcome
8:00	Open Meeting	Bill Maxwell	
8:00-8:05	Review Agenda and Groundrules	Mary Lalley	
8:05-9:00	Review and Discuss CC Meeting	John Ogle	WG members updated on CC meeting proceedings
9:00-9:45	After the FACA	Bill Maxwell	WG updated on post-FACA activities
9:45-10:00	Break	All	
10:00-11:00	Report on Coke Oven Gas	Dave Ailor	Presentation and WG consensus discussion on coke oven gas = NG
11:00-12:00	Report on Data Flow Chart	Jason Huckaby	WG updated on flow chart for presentation to CC
12:00-1:00	Lunch	All	
1:00-?	Closure on MACT Floor Documentation for Gas and “Fuel-oil” like liquids	Lee Gilmer	Decisions, action items, and consensus discussion regarding gas and “fuel-oil” like units
	Discussion of MACT Floor presentation at September CC meeting	All	Suggestions for presentation
	Flash Minutes	Heather Wright	Action items and decisions reviewed

Attachment 3

Meeting Participants

MEETING ATTENDEES

Dave Ailor, National Oilseed Processors Association
Al Dittenhoefer, Enviroplan Consulting
Chuck Feerick, Exxon Company USA
Bruno Ferraro, Grove Scientific Company
Klane Forsgren, Sinclair Oil Corporation
Lee Gilmer, Texaco, Inc.
Jason Huckaby, Eastern Research Group, Inc.
Dennis Knisley, Tennessee Eastman Division
Mary Lalley, Eastern Research Group, Inc.
Bill Maxwell, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards
Ron McCollum, U.S. Steel
Diane McConkey, U.S. Environmental Protection Agency, Office of General Counsel
John Ogle, Dow Chemical Company
Mark Poling, Drummond Co., Inc.
David Schanbacher, Texas Natural Resource Conservation Commission, Office of Air Quality
Jim Seebold, Chevron Research & Technology Company
Dave Smith, Central Soya Company, Inc.
Oliver Stanley, Cargill, Inc.
Bob Walker, Chevron Corporation
Jane Williams, California Communities Against Toxics
Heather Wright, Eastern Research Group, Inc.

Attachment 4

Database Analysis - Focus On Gas And Fuel Oil-Like Liquids

(Handouts unavailable electronically, please refer to docket copy.)

Attachment 5

Presentation: Regulation Of Sources Firing Coke Oven Gas Under The Industrial Combustion Coordinated Rulemaking

AMERICAN COKE AND COAL CHEMICALS INSTITUTE

REGULATION OF SOURCES FIRING COKE OVEN GAS UNDER THE INDUSTRIAL COMBUSTION COORDINATED RULEMAKING (ICCR)

Thursday, 30 July 1998

Meeting of ICCR Process Heater Work Group
Renaissance Hotel Long Beach
Long Beach, CA

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David C. Ailor, P.E.
Director of Regulatory Affairs
American Coke and Coal Chemicals Institute
Washington, D.C.

on behalf of

The AISI/ACCCI Coke Oven Environmental Task Force

TABLE 1. OVERVIEW OF THE AISI/ACCCI COKE OVEN ENVIRONMENTAL TASK FORCE (COETF)

- COETF is a joint undertaking of the American Iron and Steel Institute (AISI) and the American Coke and Coal Chemicals Institute (ACCCI).

- COETF represents all 20 domestic companies that produce metallurgical coke:
  - nine integrated steel companies operating 14 coke plants (40 batteries)
  - 11 independently owned/operated "merchant" companies operating 11 coke plants (28 batteries)

- COETF was formed several years ago to address environmental issues of concern to the coke industry.

TABLE 2. METALLURGICAL COKE PRODUCERS REPRESENTED BY THE COETF

ABC Coke
Acme Steel Company
AK Steel Corporation
Bethlehem Steel Corporation
Citizens Gas & Coke Utility
Empire Coke Company
Erie Coke Corporation
Geneva Steel
Gulf States Steel, Inc.
Indiana Harbor Coke Company
Koppers Industries, Inc.
LTV Steel Company
National Steel Corporation
New Boston Coke Corporation
Shenango Inc.
Sloss Industries Corporation
Stelco Inc.
Tonawanda Coke Corporation
U. S. Steel
Wheeling-Pittsburgh Steel Corporation

TABLE 3. ACTIVE DOMESTIC COKE PLANTS

STATE	COMPANY	CITY
ALABAMA	ABC Coke (Drummond Company, Inc.)1	Tarrant
	Empire Coke Company1	Holt
	Gulf States Steel, Inc.2	Gadsden
	Sloss Industries1	Birmingham
ILLINOIS	Acme Steel Co.2	Chicago
	Indiana Harbor Coke Company1, 3	East Chicago
	LTV Steel Corp.2	South Chicago
	National Steel Corp.2	Granite City
INDIANA	Bethlehem Steel Corp.2	Burns Harbor
	Citizens Gas & Coke Utility1	Indianapolis
	U.S. Steel2	Gary
KENTUCKY	AK Steel2	Ashland
MICHIGAN	National Steel Corp.2	Ecorse
NEW YORK	Bethlehem Steel Corp.2	Lackawanna
	Tonawanda Coke Corp.1	Tonawanda
OHIO	AK Steel2	Middletown
	LTV Steel Corp.2	Warren
	New Boston Coke Corp.1	New Boston
PENNSYLVANIA	Erie Coke Corp.1	Erie
	Koppers Industries, Inc.1	Monessen
	Shenango Inc.1	Pittsburgh
	U.S. Steel2	Clairton
UTAH	Geneva Steel2	Provo
VIRGINIA	Jewell Coke and Coal1, 3	Vansant
WEST VIRGINIA	Wheeling-Pittsburgh Steel Corp.2	Follansbee

1Plant is an independently owned/operated "merchant" coke plant.
2Plant is owned/operated by an integrated steel company.
3Plant is a nonrecovery coke plant.

TABLE 4. PRESENTATION OVERVIEW

- Review of "ICCR White Paper on Coke Oven Gas" (Dr. Allen C. Dittenhoefer (Enviroplan Consulting))

- Status Report on COETF Review of ICCR Process Heater Database

TABLE 5.
COETF REVIEW OF
ICCR PROCESS HEATER DATABASE

- Database includes 54 "process heaters" operated by 10 coke plants:

  - 24 of these sources are coke oven batteries firing coke oven gas (subject to another MACT standard).

  - 30 remaining sources are still being assessed.

- Review should be completed by mid-August 1998.

Attachment 6

Presentation: ICCR White Paper On Coke Oven Gas

ICCR WHITE PAPER ON COKE OVEN GAS

Presented by:

Allen C. Dittenhoefer, Ph. D.
Enviroplan Consulting
Fairfield, NJ

On behalf of:

AISI/ACCCI Coke Oven
Environmental Task Force

July 30, 1998

OVERVIEW

The combustion of coke oven gas (COG) results in very low levels of hazardous air pollutant (HAP) emissions similar to those of natural gas combustion:

1. Fuel Composition

2. Fuel Combustion Characteristics/Volatile Organic Emissions

3. Particulate Matter Emissions

4. Petroleum Environmental Research Forum (PERF) Project Results

Fuel Composition

Natural Gas: Methane (80-95%)

Coke Oven Gas: Hydrogen (50-60%)
Methane (25-30%)

Analytical data indicate that volatile HAP components (e.g., hexane, BTX, naphthalene, etc.) collectively comprise much less than 1% by volume of either natural gas or COG following conventional byproducts recovery.

Fuel Combustion Characteristics/Volatile Organic Emissions

Organic emissions are minimized by combustion practices which promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air.

Fuel Combustion Characteristics/Volatile Organic Emissions (Cont.)

- Close similarity in combustion properties (e.g., flame temperature) between natural gas and COG

- Close similarity in VOC emissions between natural gas and COG:

Fuel	VOC Emissions (lb/MMBtu)	Reference
Natural Gas	5.4×10^{-3}	AP-42 (1998)
COG	2.3×10^{-3}	AIRS (1990)

- Extremely low volatile HAP emissions from natural gas and COG combustion

Particulate Matter (PM) Emissions

- EPA emission factors indicate that PM emissions from natural gas and COG combustion are typically low and similar in magnitude:

Fuel	PM Emissions (lb/MMBtu)	Reference
Natural Gas	7.5×10^{-3}	AP-42 (1998)
COG	1.2×10^{-2}	AIRS (1990)

Particulate Matter Emissions (Cont.)

- Reported HAP metal emission factors for natural gas are very low (10^{-6} to 10^{-8} lb/MMBtu) [(Reference AP-42 (1998)]

- Based on similarity in total PM emissions, analytical composition, and combustion characteristics between COG and natural gas, it is reasonable to assume that HAP metal emissions from COG combustion in process heaters or boilers are not significant.

Petroleum Environmental Research Forum (PERF) Project Results

- Under most operating conditions, a properly maintained gas-fired boiler or process heater produces exceedingly low levels of HAP emissions, typically near or below detection limits.

- HAP emission factors for boilers and process heaters fired by natural gas and refinery process gas are similar.

PERF Project Results (Cont.)

- The different compositions of natural gas and process gas appear to have a minimal effect on flame structures and HAP emissions.

- Burner design and NO_x emission control generally have no impact on HAP emissions.

Summary: The maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than fuel composition.

Conclusion

The combustion of coke oven gas in well maintained/operated combustion units, such as process heaters and boilers, results in very low levels of HAP emissions similar to that of natural gas combustion.

Attachment 7

ICCR White Paper On Coke Oven Gas

ICCR WHITE PAPER ON COKE OVEN GAS

Combustion emissions are specific to individual site and equipment parameters, including fuel type and quality, combustor type and design, operating conditions, control device operation, and maintenance practices. The formation and destruction of organic and inorganic pollutants in combustion systems, such as boilers and process heaters, is extremely complex. Many pollutant emissions result from the incomplete oxidation of complex organic species and reactions between precursors. Other pollutants, such as trace metals, may originate in the fuel, additives, or the combustion equipment itself.

The combustion of clean-burning fossil fuels, such as natural gas, typically results in the emission of only trace quantities of hazardous air pollutants (HAPs). These HAPs include volatile organic compounds, such as BTX (benzene, toluene, xylenes), aldehydes (formaldehyde, acetaldehyde), and PAHs, as well as trace metals, including arsenic, chromium, cobalt, lead, manganese, and nickel. Based on the reasons set forth below, the combustion of by-product fuels such as coke oven gas (COG) results in low levels of HAP emissions similar to that of natural gas combustion:

1. *Fuel Composition*:

Both natural gas and COG are comprised mainly of clean-burning gaseous components. Natural gas typically consists of 80-95% methane by volume, with much lesser quantities of ethane, propane, butanes, and other trace components. COG, following conventional byproducts recovery, generally consists mainly of hydrogen (typically 50-60% by volume) and methane (approximately 25-30%), with lower quantities of carbon monoxide, ethylene, ethane, propane, and other trace constituents. Analytical data indicate that volatile and semi-volatile organic HAP components, including hexane, benzene, toluene, xylene, naphthalene, and styrene, collectively comprise much less than 1% by volume of either natural gas or COG.

2. *Fuel Combustion Characteristics/Volatile Organic Emissions*:

The rate of trace organic emissions from combustion units varies with combustion efficiency. Organic emissions are minimized by combustion practices which promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air. Although COG has a heating value of about one-half that of natural gas (i.e., about 520 Btu/CF for COG and 1020 Btu/CF for natural gas), COG has a theoretical flame temperature (about 3600^{o}F) which slightly exceeds that of natural gas. Furthermore, COG has a rate of flame propagation that is roughly double that of natural gas, which allows its actual peak flame temperature to be comparatively close to its theoretical flame temperature. This suggests that COG combustion efficiency is comparable to, if not greater than, that of natural gas, resulting in the efficient destruction of organic compounds in well maintained/operated combustion units. This is supported by VOC emission factor listings in the U.S. EPA FIRE/AIRS/AP-42 databases, which, when expressed on a lb/MMBtu basis, indicate close similarity between COG (2.3×10^{-3} lb/MMBtu) and natural gas (5.4×10^{-3} lb/MMBtu). Limited data on benzene emissions from COG combustion, as listed in the EPA FIRE database, further

show close similarity to natural gas benzene emissions (i.e., 4.4 x 10^{-5} lb/MMBtu for COG and 2.1 x 10^{-6} lb/MMBtu for natural gas).

3. *Particulate Matter Emissions*:

EPA emission factors also indicate that filterable particulate matter (PM) emissions from natural gas and COG combustion are typically low and very similar in magnitude. The EPA AP-42 (Section 1.4) document lists natural gas combustion emission factors for HAP metals, ranging from the very low values of 2.1 x 10^{-3} lb/MMCF for nickel down to <1.2 x 10^{-5} lb/MMCF for beryllium. There are no known published trace metal emission factors for COG combustion. However, based on the similarity in total PM emissions, analytical composition, and combustion characteristics between COG and natural gas, it is reasonable to assume that HAP metal emissions from COG combustion are not significant.

4. *Petroleum Environmental Research Forum Results*:

Results generated by the Petroleum Environmental Research Forum (PERF) Project largely substantiate the similarity in HAP emissions from COG and natural gas combustion. Based on extensive industrial burner emission tests, theoretical chemical mechanism studies, and rigorous analysis of data from previous field studies, the PERF Project findings indicated that:

- Under most operating conditions, a properly maintained gas-fired boiler or process heater produces exceedingly low levels of HAP emissions, typically near or below detection limits,

- HAP emission factors for boilers and process heaters fired by natural gas and refinery process gas are similar (on a lb/MMBtu basis),

- The different compositions of natural gas and process gas appear to have a minimal effect on flame structure and HAP emissions, and

- Burner design and NO_x emission controls generally have no impact on HAP emissions.

In summary, the PERF Project results suggest that the maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than the fuel composition. A properly maintained burner, within which organics are adequately mixed with oxygen at an adequate temperature, is, by design, a low HAP emissions burner.

***Conclusions**:* The combustion of COG in well maintained/operated combustion units, such as process heaters and boilers, results in low levels of HAP emissions similar to that of natural gas combustion. This conclusion is based on: 1) chemical composition data indicating that natural gas and COG typically consist mainly of clean-burning gaseous components, with minimal quantities of volatile HAPs and trace metals; 2) a similarity in combustion properties (e.g., flame temperature) between natural gas and COG, which suggests that, with either gas, good combustion practices will result in the efficient destruction of organic compounds; 3) EPA emission factor information, which indicates close similarity between natural gas and COG in

total VOC, PM, and benzene emissions (expressed on a lb/MMBtu basis), and 4) recent findings from the PERF Project suggesting that the maintenance and operation of gas-fired combustion units have a far greater impact on HAP emissions than fuel composition and, under most operating conditions, a properly maintained gas-fired unit produces exceedingly low levels of HAP emissions.